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ABSTRACT

A "whole school" approach to computer use is explained and a high school teacher gives examples of computer utilization in his school to suggest the variety of potential applications. The examples are business education, student scheduling, social studies, chemistry, and remedial mathematics. The method of application in each case is simulation. The authors conclude that the computer is a shared resource for the whole school--students, teachers, and administrators. (DAG)

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The Illinois Series on Educational Applications of Computers

APPLICATIONS OF COMPUTERS IN THE WHOLE SCHOOL - FIVE EXAMPLES

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APPLICATIONS OF COMPUTERS IN THE WHOLE SCHOOL - FIVE EXAMPLES

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"Computers in the whole school" is a philosophy of computer use in the schools which is rich in content, community, and effectiveness. In other papers in this series we will examine in some detail various aspects of computers in the whole school. In this first paper our objective is to make the philosophy explicit. We will first listen to a high school teacher explain five ways the computer is used in his school, then briefly describe the implications the examples have on the philosophy of computer use in the schools. Although such a small sample cannot show every facet of the variety available, five examples will be enough to introduce some of the variety and to suggest some of the power of this approach to computer utilization in the schools.

The characteristics of the five examples are summarized in Table 1. Notice that these computer applications vary in their content or subject area, their type (instructional or administrative), the clientele (students, teachers, or administrators), who did the programming, the size of the program, and whether simulation was used. Let us accept this indication of variety at face value and return to a more detailed examination of it after describing each program.

Table 1. Characteristics of Five Educational Applications of The Computer in the Whole School

Application Area	Type[a]	Clients[b]	Programmers[b]	Size of Program[c]	Simulation Used?
Business education	IAC (AAC)	S,T,(A)	S - business and math ed	L	Yes
Student scheduling	AAC	S,T,A	S, T - math ed	L	Yes
Social studies	IAC	S,T	S - social studies	M	Yes
Chemistry	IAC	S,T	S - chemistry	S	Yes
Remedial mathematics	IAC	S,T	S,T - math ed	S	Yes

[a] IAC = instructional applications of computers
AAC = administrative applications of computers

[b] S,T,A = students, teachers, administrators

[c] S = small - requires less than 4 hours of programming
M = medium - requires 4-20 hours of programming
L = large - requires more than 20 hours of programming

Five Examples of Computer Use

In a room which houses the school's computer, you are talking to a mathematics teacher who is in charge of computer services. He has an office next door and a senior student watching to make sure things are kept in line. He describes to you how the students, faculty and administrators use the computer in his school, telling you that the philosophy of the mathematics department (which has primary responsibility for the computer and its use) centers around, "Mathematics: queen and servant of the sciences," with emphasis on the servant aspect.

Business Education*

"The first students coming in today are business education students with their own data cards and a BASIC** program written for them to generate the balance sheet, profit and loss sheet, and production statement. One of the exciting things about that, for me as a mathematics teacher, and as someone who knows nothing about commerce, was trying to collaborate with the commerce department about how commerce is generally taught. In my school, you teach business by teaching how to fill in blanks in a ledger. Talking to business students I have found that they don't have much understanding of what business is about and why a financial statement is an interesting statement to read. They learned only to produce these documents.

"I remember that when we introduced the computer, they were studying

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* The material in quotation marks, here and in later sections, was taken from Reference 1 and put in the form of a discussion with the mathematics teacher. The authors wish to acknowledge the expert assistance of Linda Crider in the preparation of this material.

** The programming language used is called BASIC.

ways of handling insurance on vehicles which the company owned. In the computer room we handled this problem in numerous different ways with matching sets of data and turned out a complete set of books for the company with ratings of the various bases.

"And do you know what they wanted to do when they went back to the commerce class? Instead of just filling in ledger blanks, they discussed their data, and found reasons why it should be handled in one way rather than another. 'What is the purpose of all this,' they asked themselves. 'Which is the preferred method of keeping books for each kind of business?' The students themselves then developed a comprehensive accounting program. (It was beyond my competencies at the time.) Mathematics students and commerce students worked together. The head of the commerce department and I stayed out of it, as much as possible.

"Now one junior-senior level accounting class is operated as a hypothetical company. Students are the officers, the head of the commerce department is chairman of the board of directors, and, since I am in charge of the computer center, I am president of the corporation. A student is stationed at a desk by the door to act as receptionist and monitor the inflow of information while the systems are operating. Students who show particular interest in computer operation are the data-processing department. The sales department produces orders. The purchasing department produces inventory. The heads of each department organize a system for operating the company. The usual company problems are handled in the usual ways. The personnel manager has to deal with the gum-chewing receptionist. The buyers meet with the sales personnel about selling (non-existent) inventory. The data-processing manager complains to everyone about 'dirty data' and illegible documents. The business teacher and I only adjudicate arguments and serve as resource people. Our goal is to teach 'systems,' the interdependence of people working together. We feel

that the 'unforgiving' computer, with its demand for consistency and accuracy, is an effective teacher."

Student scheduling

"Those who have anything to do with the administration of a school know that although a good timetable doesn't make a good school, a bad timetable will nearly always wreck a school.

"We started scheduling with a very small computer setup. On the average we had two boxes of cards coming per hour and we were really pushed to process them because we had no line printer. Our school board just had had a referendum defeated and we were out of money. We didn't know where the money was going to come from to buy our printer which would cost $12,000.

"We got the money from our student scheduling program! The printer is now on order because the schools in our district no longer pay $2,500 each to an outfit in California to schedule our schools. Now each of the schools in the district will spend that money to help buy a printer with which to do scheduling. The student scheduling program provided money for a printer that the whole school could well use.

"It did a lot of other things. The principal is now proud of what he calls his $30,000 machine. It was something that came out of the math department and he never expected to get any help from that department for any administrative activity. But now we have provided a service, and he thinks of its effect on the parents, the school board, and the students. Instead of having to copy out his timetable, each student gets two copies showing each period, room number, teacher's name all in a beautiful simple-to-read form. Parents seeing this printout glow because it shows what progressive schools are theirs, and the school board basks in reflected glory...the first district in the province...."

Social studies

"Some grade nine students were concerned with what they thought was their teacher's lack of logical ability, and a tremendous argument ensued. So four kids who were pretty good in math sat down and decided that they would write a program to test hypotheses in history.

"They listed 18 countries in an array, in the computer, along with 30 questions called 'criteria.' The 'criteria' would be tested for each of these countries: criteria ranged from 'amount of rainfall' to 'method of achieving independence' and so on. Students could then list the criteria (by number) that they were interested in, and how important each was, and then get a printout of the 'scoring' order for each country.

"Now, of course, the first problem the kids had, and you may think about the difficulties in logic, was to find a code, because they were working strictly numerically, to represent the data. Well, the rainfall is easy. But how do you do things like 'method of achieving independence?'

"I sat in on the class and let them carry on. They decided on the following system: a scale from '0' representing 'never was a colony' to '6' for 'quite bloody revolution.' How do you distinguish? Do you measure the blood? They were already revealing the sorts of things that cause arguments. Next they broke into groups to decide how to go collect information.

"One question was 'to what extent is the country self-sufficient in dairy products?' That was where the second problem surfaced, for when this was all finished and I tested the results, I kept getting Greece down at the bottom and Canada always at the top. Yes, we have a lot of nationalists.* I didn't understand this so I checked the encyclopedias the students used and found that if Canada produced from 35 to 45 percent of a commodity, the computer

* Your discussions with the mathematics teacher are in a Canadian school but could also have taken place in a number of schools in the United States.

printed 55. Whereas if Greece produced from 15 to 20 percent of its own milk, we had 10 or 15 stored in the machine by the student. The students had slanted the data.

"This, of course, illustrated very real problems in all scholarly work. First, how do you define your criteria and second, how do you make sure that your data are correct? The social studies teacher was pleased that the students could comprehend and discuss these important problems. The four student programmers ended up with a program which I insisted had to be used by those kids who didn't know much about using the computer and didn't want to program themselves. Those who were able to, wrote their own program.

"The computer (See Table 2) first tells the user 'Type 0 for no and 1 for yes.' Even the student who didn't write the program becomes familiar with such coded answers. The computer then asks 'Do you wish to change the criteria?' and if the answer is 'yes,' it types out the procedure for changing one of these questions. Then it says, 'Name the criteria in testing your hypothesis.' The students note the decisions built into the program, the same sort of decisions made in well-organized 'hand' work.

"The first hypothesis a student wanted to test was: 'If a country is very religious, it has a violent history.' You can see they were thinking of bloody religious wars, so two of the criteria were the percentage of people who were Christians and the percentage of people who were Moslem. Other questions had to do with the relationship between an official church and the state and so on.

"All the criteria were numbered from 1 to 30. You typed in the numbers of the criteria you want, say, '2,5,7,' and the computer asked 'How do you want to weight these?' You might have weighted them in the proportion of 1:3:-2. Whether or not your hypothesis was correct, the computer would type

Table 2. SAMPLE--Social Studies Printout

```
RUN
ALWAYS FOLLOW THE TYPING OF A NUMBER WITH THE RETURN KEY.

DO YOU WISH TO ESTABLISH OR CHANGE THE CRITERIA?
TYPE 1 FOR YES OR 0 FOR NO
?0

YOU ARE NOW ASKED TO NAME THOSE CRITERIA YOU WISH TO CONSIDER IN TESTING YOUR
HYPOTHESIS, AND HOW MUCH YOU WISH TO WEIGHT (POS OR NEG) EACH CRITERION. ENTER
0 IN BOTH COLUMNS TO INDICATE NO MORE CRITERIA ARE TO BE ENTERED

CRITERIA                        WEIGHTING
?5                                 2
?15                                3
?16                               -1
?3                                 1
?0                                 0

YOUR HYPOTHESIS YIELDS THE FOLLOWING LIST OF COUNTRIES FROM HIGHEST TO LOWEST
TOTAL SCORE

VIETNAM
BRAZIL
JAPAN
INDIA
CZECHOSLOVAKIA
GREECE
AUSTRALIA
CANADA
ISRAEL
EGYPT
NIGERIA
SOUTH AFRICA
CHINA
MEXICO
FRANCE
U.S.A.
RUSSIA
BRITAIN
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out a list of countries exhibiting these characteristics from the greatest to the least extent. If your hypothesis was correct, you should have at the top countries which obviously had very violent histories and at the bottom countries which had peaceful histories.

"Now, how do you think it turned out? The students received a 'garbage' list of countries, of dourse, a list which bore no relationship to the hypothesis. They wondered why. Well, one of the things which happened was that some kid decided Islamic people are particularly violent, so he put 'criterion: percentage Islam' and he weighted that 1,000. Do you see what happened? He at least had to declare his prejudice because it was on paper for everyone to see. He declared what amounts to a very gross prejudice and he had to state it, which he may not have to do in an argument in class.

"Well, if you change data, criteria, and weighting, get another list, and it still doesn't represent what happened, then you begin to apply those things you have learned in social studies class. Perhaps it occurs to students that history is not easily analyzed on only 30 criteria. If their own guesses as to the nature of things weren't any good, they begin to wonder how the social studies textbook would fare.

"Using a text which mentioned 'the eight causes of the second world war,' they put in these eight criteria and they got a list of countries which should have ranged, if the criteria had been complete, from most involved to least involved in the hostilities. Do you know, who was at the top? Using the text's criteria, the computer listed the countries from poor to rich, when the countries most involved in the war were rich. Well, the book had relied heavily on economic reasons for war. A very slanted book. There are many causes of war besides economic ones.

"You can see the sort of changes that occurred in student thinking--the computer demands that you be consistent for a moment and then 'live with' the results--or change the input. Students could see value in a somewhat mathematical approach to history. You can see that even if the kids come to the conclusion that a computer is a very bad way of analyzing questions like that (and certainly it is), they have come up with something very profound, I think.

"There are two things to know about computers, what they will do and what they won't. And I think the second is by far the most important, but not intuitively obvious. Students must experiment to find limits of computer applications in a given area."

Chemistry

"Is there a difference when the science people get involved with the computer? Here's how the head of the chemistry department works it.

"A week before a laboratory assignment the student is given the task of writing a program to handle the data which has not even been collected yet. Every student has learned how to write a simple program. That means the student reads about the lab experiment before doing it. How would most kids be prepared when they walk into the lab? They wouldn't even know the title of the lab they are supposed to do. If you are a teacher who is hooked on 'scientific approach' and 'inquiry,' this is somewhat infuriating. But now the student has to figure out before the lab what he is supposed to do in the lab because he has had to write a program. If you had any programming experience, you know that you have to know all about what you are going to do before you can write and run your program successfully. That's the first advantage of computer involvement.

"In the lab, he has one or two cards for recording data. He does the lab experiment, collects the data, puts the data on the card, and hands the

data and the program to his teacher with his name on the back of it. The teacher then puts the data cards and programs through the machine. Note that the teacher puts it through the machine. Reason: First of all, the teacher has got a check built into his program (which precedes the student programs) to make sure that the data is actually handled, that the program is not just constructed to ignore data and turn out theoretical values; second, the problem of students disguising their learning problems by producing what looks likes an answer is circumvented.

"What has the teacher got from all this? A very neat, typed explanation of what the student thought was going on. For example, if he thought the increase in the length of an iron rod was so many degrees Centigrade--some absurd answer--the teacher can see it and can handle the problem right on the spot. The error is obvious and its correction immediate."

Remedial mathematics

"Here is a sample of a remedial program--written with my help and fed into the computer by the student, with values of A and B that he chooses and writes* on a DATA card.

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* We use mark-sense cards that we write on with pencil. No key punch is needed.

Table 3. SAMPLE--Remedial Math Printout

```
 10  Read A, B
 20  Let S = A + B
 30  Let D = A - B
 40  Let P = A * B
 50  Let Q = A/B
 60  Print  "If A equals" A "and B equals" B
 70  Print  "Then Sum equals" S
 80  Print  "Then Difference equals" D
 90  Print  "Then Product equals" P
100  Print  "Then Quotient equals" Q
110  Go to 10
120  End
 Run

115  DATA  24,8
```

"The student works out the answers by hand. Why is he adding and subtracting by hand? Because he has to check to see if his program is good. He also does not have to hand in both computer and hand results until these are the same. The effectiveness of the program depends upon the fact that drill is practiced and corrected using the impersonal machine. The teacher sees only success.

"O.K., what does this do for a kid who cannot add in grade eight? Well, if you try to teach kids who can't add when they get to grade eight by traditional means, you're just plain (among other things) arrogant. You are assuming that the seven previous teachers they had knew nothing about teaching, and you are the only person who does. They may have had some rotten teachers but presumably they had not had seven of them. So it's going to have to be attacked in a new way.

"The success of this remedial use of a computer depends on how badly off the student is and how much help you supply. But the kids go home and say,

'Mom guess what I did today?! and Mom says (or thinks), 'I know, they tried to get you to learn your addition facts today--for the eighth consecutive year--and then you left remedial math and you went to remedial English and they tried to get you to learn to read!' 'No, Mom, we programmed the computer!!'

"All right, to you that's schmaltzy, you don't buy it. You may think the student will say, 'Look, I know what you want me to do, you want me to do a whole bunch of adding, subtracting, multiplying, and dividing, so maybe eventually I will learn to do it.' Or maybe the kid does know that, but at least it's new and prestigious.

"So do they all miraculously become marvelous arithmeticians? No, they don't. Does it help? Yes, we think so. Can this alone justify putting a computer in the schools? No, obviously not. But it is quite useful and it is quite exciting to see kids, some of them for the first time, take home something that can be read and contains correct answers, something which is truthfully their own, legible, error-free work! It is a new start. They don't need 50 different programs, either. They will use this one for a month while making these numbers bigger and bigger and bigger--and then putting in decimals and fractions and percents. These students do not need more variety--they need repeated success."

Discussion

We have listened to the mathematics teacher describe five examples of educational applications of computers in his school. We are thus ready to examine what Table 1 suggests about the examples.

Four of the five applications are clearly instructional. One of these, in business education, has future potential relevance to management and business operations of the school, and is therefore marked with (AAC) in the Table to suggest such administrative applications. The second example, student scheduling, is useful to administrators, teachers, and students. It facilitates the instructional purposes and activities but is not itself instructional (except as an example for the more advanced students of one application of computer programming).

Each of the five applications serves students: sometimes all students, sometimes one at a time; at other times, those in one particular class or course. Each also serves the teachers, in one way or another, to carry out their functions in the educational processes. The administrators are served indirectly by the first application and directly by the second one.

In four of the five examples the programming is done primarily by the student or for his particular purposes, illustrating the central role of the student in computers for the whole school. The teacher gives assistance to the student in one of these, the remedial mathematics, and both learn something substantial about the student's problems with arithmetic and how to solve them. The second application, student scheduling, was programmed primarily by the mathematics teacher.

The variation in size of the programs is typical. The larger programs tend to be those which serve many students. The smaller programs are likely to be those which serve the needs of individual students.

It is perhaps surprising that simulation was used in each of the applications. To explain this consistency we need first to recall what simulation is. A computer program provides simulation when it models some process (Reference 2). What processes are modeled in the five examples?

In business education the computer calculations model the process of keeping the records and accounts of the company (and the students model the process of running the company). In student scheduling the computer program utilizes a restricted model of the full scheduling for the school, makes what scheduling decisions it can and says "help" when it detects a conflict that only a human being can resolve! In social studies the computer forms a restricted model, of the processes in history that lead nations to be peaceful or warlike. (To be more exact, the processes are not explicitly simulated but only the alleged causes and effects of historical processes.) In chemistry each student simulates a part of his experiment by describing the data he expects to take and how it is to be analyzed. In remedial mathematics the computer provides a simple simulation of the student's arithmetical powers; the student then checks the accuracy of this "simulation" by comparing with his own hand calculation (a nice reversal of the usual "computer checks student" mind-set of teachers).

Although these examples do not exhibit pure simulations (as would, for example, simulations of water pollution or population dynamics) they do illustrate the simulational aspects of a variety of computer applications.

In our introduction we claimed that the philosophy of "computers for the whole school" was rich in content, effectiveness, and community. The five examples illustrated a variety of content in the computer applications and have also illustrated many aspects of their effectiveness in the school. What about community?

It is clear that the computer is a shared resource for the whole school, that is, for students, teachers, and administrators. This dimension of community--of sharing, cooperation, and understanding--is suggested both by the Table and in our discussion of it. Other dimensions of this community are: 1) the computer language (BASIC) and its use; 2) an understanding of both the power and the limitations of computers; 3) familiarity with the roles of problem-solving and rational design, where these are relevant in a school; 4) new roles for students, teachers, and administrators that are both visible to and appreciated by the whole school community. ("I value your role in applications of the computer even though I may not understand it as well as my role with the computer.") It is this last aspect of community which is perhaps the most important characteristic of "computers for the whole school" when this philosophy has been successfully put in practice.

References

1. Wm. P. Goddard, "Computers and the Whole School." Workshop on computer mathematics for teacher educators, November, 1971 at the University of Illinois.

2. Guetzkow, H., et. al., "Simulation in Social and Administrative Sciences; Overviews and Case Examples." Prentice Hall, Englewood Cliffs, New Jersey: 1972, Chapter 1.

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